

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

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In the Matter of)
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Advanced Television Systems)
and Their Impact on the)
Existing Television)
Broadcast Service)
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Review of Technical and)
Operational Requirements:)
Part 73-E, Television)
Broadcast Stations)
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Reevaluation of the UHF)
Television Channel and)
Distance Separation)
Requirements of Part 73 of)
the Commission's Rules)

MM Docket No. 87-268 /
RM-5811

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NOV 18 1987

Federal Communications Commission
Office of the Secretary

To: The Commission

COMMENTS OF RADIO TELECOM AND TECHNOLOGY, INC.

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COMMENTS OF RADIO TELECOM AND TECHNOLOGY, INC.

Summary

1. Radio Telecom and Technology, Inc. ("RTT") hereby submits these Comments in response to the Commission's Notice of Inquiry in the above-captioned proceeding, FCC 87-246, released August 20, 1987.

2. The objective of these comments is to urge the Commission to broaden its perspective in addressing advanced television systems ("ATV") to include not only more sharply defined pictures and higher fidelity stereophonic sound ("HDTV") but also enhancements of other kinds, including two-way interactive television, where viewers can communicate instantly with the television station they are watching. RTT has developed a system that can accomplish this objective and, unlike HDTV, is ready for implementation immediately.

3. The Commission should take action in 1988 to allow RTT and others to put their inventions to work in the market place rather than freezing all

development of television technology until the complex process of arriving at a new standard for HDTV pictures and sound is completed. The freezing of technology would disserve the public interest by depriving the public of new and innovative services. It would retard the development of television enhancements by relegating the process of invention to committees and paper work rather than the field and the marketplace, where all inventions must ultimately be tested and proved if they are to survive.

4. Section 7 of the Communications Act mandates that the Commission encourage, not freeze, technological development. Thus at least in the case of T-NET, which would not interfere with any existing transmissions, would not be mandatory and thus would not impair the development and implementation of any future HDTV system, and would not impair future flexibility with regard to land mobile allotments, authorization to deploy the system should be granted now, not later.

5. A partial relaxation of the NTSC standard would permit the immediate implementation of T-NET. That relaxation may be limited and need not extend to allowing variations in the fundamental NTSC video/audio scheme that is displayed on conventional television receivers. Rather, all that need be done is to authorize variations in only those portions of the TV signal that are blanked out on conventional receivers. Thus T-NET may be implemented without the risk of impairing the mass market economies of scale which have resulted from the present system of mandatory interoperability and which many broadcasters want to enjoy with any future HDTV system as well. T-NET may also operate without any change in existing interference protection standards in the television spectrum.

Radio Telecom and Technology, Inc.

5. RTT is a research and development firm located in Cerritos, California. Its staff is made up of highly experienced engineers with many accomplishments to their credit. Its principals, who are former principals of Altran Electronics, Inc. (later the Altran Division of McGraw-Edison Co.) have worked with broadcasters and the Commission in the past on compatible broadcast-based data technologies, including the technological development and the rulemaking providing for data transmission via AM broadcast carriers (Section 73.127 of the Rules). Mr. Louis Martinez, RTT's President and principal stockholder, holds a number of patents in the radio art.

6. RTT's staff has considerable experience in radio wave propagation, modulation and systems design. They have been particularly concerned in the past few years with evaluating issues relating to television interference such as might be caused by auxiliary signals operating in channels adjacent to TV signals. An especially important finding of this research is the concept which RTT has defined as "synergetic" modulation. RTT has found that it is possible to design auxiliary or augmenting signals in the time and/or frequency domain in such a manner as to minimize the mutual interference between it and existing primary radio wave signal such as NTSC television. The technology which has evolved from these concepts permits new signals to be employed co-channel or in vacant adjacent television channels without causing interference to existing television signals. RTT calls a specific embodiment of this technology "T-NET".

Overview of T-NET

7. RTT has developed a new technology called "T- NET," which permits the two-way wireless transmission of data on previously unusable television channels first adjacent to, and in the same market as, an operating VHF or UHF television

station, or even on the same channel as an operating station. The system, by virtue of its design, cannot create perceptible interference to the reception of any television station, either in the same or a distant community. T-NET may be used for program related and/or non-program related services. As a program related system, it allows a viewer to "talk back" to the host TV station, with a keypad, a computer terminal, or even a voice device. T-NET is suitable for interactive television applications such as home shopping and banking, instantaneous viewer surveys and educational functions, as well as for data communication generally.

8. T-NET's two-way interactive television is unquestionably a major enhancement of the television art, just as much as HDTV's high resolution picture and high fidelity sound. Indeed, whereas HDTV involves broadcasters trying to catch up or keep pace with other technologies, such as cable, DBS, and videotape, two-way interactive television will be easier for broadcasters to implement and so may be a superior enhancement to HDTV in that broadcasters will have it first, not last.

9. To ignore inventions like T-NET in an inquiry about ATV would be to wear blinders in an age where technological advancement is, and will continue to be, rapid and very broad in scope. Every enhancement to the television art must be considered, certainly including two-way television. Since it should be obvious that the process of invention and refinement will never stop, the Commission must not try to freeze technology now and then "leap" to a new level which is again frozen. Rather, the Commission must develop a regulatory structure that creates a pathway for long term, continuing improvement, subject only to the caveat that a limited number of basic constraints or standards may be appropriate so that consumer investment is not wasted and economies of scale may be enjoyed.

10. T-NET has been before the Commission previously, principally in General Docket No. 85-172, where RTT urged (unfortunately without success) the adoption of certain rules proposed in that proceeding be adopted that would allow T-NET to be implemented. In that proceeding, RTT described T-NET in detail. Appendix A hereto is an excerpt from RTT's Docket No. 85-172 comments, filed July 11, 1986, discussing the system.

11. The instant proceeding presents a second opportunity to allow the public to enjoy the benefits of T-NET. There is no reason to pass up that opportunity and every reason to take advantage of it. Thus RTT urges the Commission to issue a Notice of Proposed Rule Making early in 1988, looking toward a limited relaxation of the NTSC standard that will allow T-NET to be deployed no later than late 1988, and earlier if possible.

RTT's Developmental Work

11. The theory of the T-NET technology is particularly relevant to this proceeding because it throws some light on the question of how to define and evaluate "interference". All of the intermodulation products and taboo frequencies discussed in the Commission's NOI are based on preconceived notions that interfering signals are independent, continuous in time, and/or exist in specified frequency ranges all of the time. One cannot evaluate the interference potential of a new signal until a clearer understanding and definition of that signal's parameters is established. Alternatively, one can design the time and frequency parameters of an auxiliary signal so as to minimize or totally eliminate its effect on a companion adjacent channel existing television signal. That is the goal of synergetic modulation. It would be a serious restraint of technology development if the Commission did not recognize concepts such as T-NET and disallowed them on a wholesale basis because of preconceived notions prohibiting new signals that bear certain frequency relations such as $N + 2, 3, 4, 5$, channels removed from the protected signal. Accordingly, the Commission should relax its rules early on and encourage technical and market tests of new technologies.

12. RTT has evaluated several of the proposed ATV systems. On this basis, and based on research which RTT has itself conducted on techniques to increase the information capacity of an existing 6 MHz allocation, RTT believes there is a high probability that an ATV system can be devised that is not only compatible with NTSC, but which will also fit within the existing 6 MHz spectrum. RTT's own concept of ATV is based on studies and experiments designed to add substantially more information carrying capacity to existing NTSC signals in a noninterfering basis. In view of the fact that these new RTT techniques are still proprietary, and in view of the fact that this is not the appropriate forum to

discuss technical details, we shall not comment further at this time but wish to reiterate our belief that there is a high probability that an acceptable ATV system is achievable within the 6 MHz allocation.

The Process of Invention

13. RTT plans to participate in the work of the Industry Advisory Committee that will be addressing ATV systems, but it is uneasy about the heavy reliance that the Commission appears to be placing on the work of that committee. Committees can develop concepts and chart pathways for future changes in technology, but they cannot themselves create new inventions. It is obvious to most experienced inventors that their cognitive process generally concludes in one or both of the following: (1) a very clever and unique statement of the problem to be solved, which statement itself may appear to be invention but which nevertheless is not patentable under U.S. patent rules, and/or (2) a very clever and unique solution to that stated problem, or a recognized problem such as ATV, which solution might be patentable.

14. One would hope that the Commission's new ATV committee would come up with that unique statement of the problem to be solved, but this is unlikely because such cleverness, even if it is unpatentable, is a personal, not a committee, attribute and is generally recognized as proprietary by that committee member or any participant worth his salt. Thus, the ATV Advisory Committee's activities will boil down to evaluating various proprietary proposals, probably in proportion to the strong lobbying efforts related thereto. To think that the committee itself would invent the ATV solution is fanciful thinking. Although it is not likely, one would hope the ATV Committee could develop a unique or novel "breakthrough" statement of the problem to be solved (i.e., a useful specification of what is to be done, or even a guideline). As a practical matter, however, every

interested party in this proceeding knows that what is desired is thge following: an ATV system with at least one thousand lines of horizontal and vertical resolutiuon which is compatible with NTSC and stays within the existing 16 MHz channel bandwidth or perhaps a few MHz more. Anyone who can achieve trhis, or come closest to it (in the eyes of the Commission and Committee), is the winner, providing they have the financial and political clout to press their case and the willingness to do so. All of the rest of the Committee's activities and ceremonies will be primarily window dressing to soothe the protagonists in the UHF TV/land mobile sharing argument.

15. While these efforts are in progress, neither the ATV committee nor the Commission should shut their eyes to new competitive options, which they would if they focused only on HDTV. If broadcasting is to enjoy the advancements and enhancements that are already being developed through trial and error for other technoligties, the Commission must allow some latitude for experimentation early on.

16. RTT has already conducted substantial experimentation not only in the laboratory but also under an Experimental Licenses, call signs KA2XBE and KB2XBN, at both VHF and UHF. It has proved that T-NET works in the field and is ready for widespread use. Now it is time for the Commission to allow the marketplace to have its say as to whether T-NET will ultimately succeed or fail.

17. A freeze on technical standards will not permit the Commission or anyone else ever to find out whether any new technology, T-NET or otherwise, will really take hold or will fizzle and remain an unrealized dream. And the longer any freeze remains in place, the longer the nation will remain in ignorance about what our creative abilities can offer.

Specific Spectrum Rules

18. RTT urges a limited relaxation of existing NTSC standards and bandwidth limits to allow T-NET and other innovative technologies to be implemented now, without limiting any future ATV options. Three principles should be incorporated in these rules:

(a) Additional signals may be transmitted during the blanking interval or other unused portions of the existing 6 MHz channel.

(b) For the time being, no variation shall be permitted in the existing NTSC waveform that would result in perceptible degradation of reception of color video, monochromatic video, monaural audio, or BTSC stereophonic audio on existing NTSC color or monochrome television receivers; nor shall the transmission of non-standard signals justify any displacement of a station's broadcast programming service to the public.^{1/}

(c) Emissions outside the authorized 6 MHz bandwidth and within the first adjacent 6 MHz channel, shall be permitted, provided that the signal radiated toward any co-channel or adjacent channel station may not exceed the levels that may be unintentionally radiated by a conventional television station operating in full conformance with the spacing requirements set forth in the current rules.^{2/} In other words, intentional levels may be held within existing unintentional limits.

^{1/} The authority for subscription TV operations, as set forth in Section 73.644 of the Rules, could remain as an exception to this principle.

^{2/} These levels are -20 dB for the lower sideband for a modulating frequency of 1.25 MHz or greater, -20 dB for the upper sideband for a modulating frequency of 4.75 MHz or greater, and -42 dB for the color subcarrier frequency. See Rule Section 73.687(a)(1).

Regulatory Structure for New Technologies

17. RTT strongly endorses the proposals set forth at Paragraphs 105-107 of the Notice of Inquiry regarding the regulatory structure for new services, whether within the existing 6 MHz or the adjacent channel as described in Paragraph 16 of these Comments. These principles are most likely to encourage the early implementation of a broad range of new technologies and services without regulatory burdens that might otherwise discourage innovation. They include the following:

(a) Spectrum capacity should be made available to the existing television licensee.

(b) The existing licensee should determine whether the spectrum is used for broadcast or non-broadcast purposes.^{3/} Neither type of operation, nor any operation at all for that matter, should be mandatory.

(c) Except where the spectrum is used for the primary channel broadcast program, new spectrum uses should be treated as ancillary, using the subcarrier and vertical blanking interval models. Title III broadcasting obligations should not apply, and broadcasters should be free at will to implement new services, subject only to notifying the Commission.^{4/}

No Impairment of Future Flexibility

18. It is important to note that where a new service is totally discretionary, as RTT recommends for T-NET, there will be no impairment of future flexibility, on the part of either the Commission or the broadcasting industry, to adopt and

^{3/} Like the VBI and aural subcarriers, T-NET obviously has significant non-broadcast applications as well as broadcast-related ones. The broadcast-related concept of interactive television has been stressed in these comments, because the purpose of this proceeding is to explore enhancements of the television art.

^{4/} Since the use of adjacent channel spectrum is something new, it might be appropriate, at least until more experience is gained, to require a showing of non-interference to accompany any notification of the initiation of service.

implement any kind of new ATV system that may be developed and found desirable in the future, whether as a mandatory standard or an optional system. If a station is using T-NET and something better comes along, the station can simply discontinue T-NET and move to the new system. Conversely, if the station finds T-NET more desirable, it will stay with T-NET.

19. Some will argue that because it will utilize adjacent channel spectrum, T-NET will necessarily interfere with the use of that same spectrum for ATV. And since the first adjacent channel is a prime candidate for ATV, the argument continues, it is vital that no other service be permitted to use that capacity until a final decision is reached on ATV standards. Even if T-NET is optional, it could become sufficiently entrenched that it will be difficult to displace in the future. Such an argument is simply invalid, for at least two reasons. First, if T-NET becomes so entrenched that neither the broadcasting industry nor the public wants to give it up, the Commission should be pleased at the enhancement it has fostered and should certainly not be concerned that no one wants to forego that enhancement. Second, the argument fails to understand the technical nature of T-NET and its inherent inability to cause interference.

20. T-NET utilizes spectrum spreading techniques and operates at average power levels thousands of times below the power levels used by broadcast transmitters -- at milliwatt levels in the case of the return link from the end user to the central location. Thus its interference potential is orders of magnitude lower than the interference potential of a signal that would have to be transmitted by a television station to convey HDTV picture and sound enhancement information to home television receivers.

21. The broad use of first adjacent channel spectrum for HDTV will be difficult, unless the Commission is prepared to see a dramatic reduction in the

service area of over-the-air television broadcast stations, because the need to protect another station (which may be as near as 55 miles) will always pose a serious problem.5/ This is not to say that there are no solutions to that problem, but there will always be a significant constraint which will prevent full power transmission outside the existing 6 MHz bandwidth without regard to other stations.

22. In contrast, T-NET's miniscule power levels can have no impact at all on distant stations, and since the T-NET signal is coherent with the local station, it cannot interfere with reception of the local station either. In other words, some spectrum capacity will of necessity be unusable for HDTV, and that capacity will be available to T-NET. Whether the available capacity is more or less will affect only the number of subscribers that T-NET can serve, not the basic viability of the system. That is the beauty of T-NET. Because of its low power, there will always be room for it where other services cannot exist, in spectrum that is especially hostile to any kind of high powered operation because of receiver characteristics and the pattern of channel allotments.6/

5/ Even if no station exists at or near 55 miles away on the adjacent channel, adjacent channel signals will interfere with reception of the primary local station on today's tens of millions of NTSC receivers. In other words, if a TV station on Channel 50 wishes to use Channel 49 for HDTV enhancement, it must deal with interference to not only a Channel 49 station 55 miles away but also its own local Channel 50 signal.


6/ Moreover, every TV station has two adjacent channels, one above and one below. If one of these is used for HDTV, the other will still be available for T-NET; or if half of each is used for HDTV, the other half of each will be available for T-NET. Even if there are a few stations where allotments are so tightly intertwined that it is not possible to find spectrum for both HDTV and T-NET, there is no cause for concern. Such instances will occur, if at all, only in multi-station markets, and it is unlikely that every station in a crowded market will want to use T-NET. If one cannot, another will, and those who are able should not be prevented from doing so.

Conclusion

23. In General Docket No. 85-172, many broadcasters, large and small, as well as other potential users, enthusiastically supported the advent of T-NET. No one, either on the broadcast or land mobile side, opposed it.^{7/} It is now time for the Commission to act. There is a regulatory opportunity in this proceeding to provide a substantial benefit to the public, and there is no need to hold back T-NET to preserve options for future new developments. Under these circumstances, the Commission's statutory mandates to encourage new technologies and to act in the public interest, convenience, and necessity require an immediate rule making and approval of relaxed rules to permit those who wish to use T-NET to do so at the earliest possible date.

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^{7/} To the extent that any ambivalence was expressed at all, it was limited to urging that T-NET be considered in a separate proceeding rather than in the context of land mobile/UHF-TV spectrum allotment. We now have such a separate proceeding.

24. The T-NET system design employs three separate mechanisms to insure compatibility with an adjacent channel television signal and to improve its own transmission reliability. These mechanisms are summarized below and discussed briefly in the following paragraphs.

(1) It coordinates T-NET transmissions with the "Host" television signal so as to prevent or reduce interference to a negligible level,

(2) It uses the television signal to coordinate a time frequency-space division multiplexing mode to permit upward of 75,000 simultaneous independent transmissions, and

(3) It employs a new modulation method, referred to by RTT as "synergetic modulation," whereby T-NET

3/ A T-NET system in a given city might be constructed and managed by a network operating company functionally similar to a telephone company, radio common carrier (RCC), or value-added network, generally operating as a private carrier contracting with Service Providers rather than individual subscribers. The network operator itself might also be a large Service Provider, leasing excess capacity to others.

inbound and outbound transmissions on an adjacent channel appear like sidebands on the host TV signal to thereby enhance T-NET transmission reliability.

25. With regard to the first mechanism, preventing television interference, it is important to distinguish the various functions that television signals are designed to accomplish. These include the transmission of video and audio signals, horizontal and vertical synchronization, black-level reference, color subcarrier phase reference, and certain stereo and secondary audio programs. In some cases, there is also the auxiliary function of teletext or other vertical blanking interval (VBI) services. The latter information is transmitted on a few horizontal lines during the VBI. Most studies of television interference, if not all of them, have focused attention on visual and audio interference perceivable by humans. Since information visible to the viewers is only transmitted about three-quarters of the time, this leaves one-quarter of the time to transmit such "invisible" things as synchronization and reference parameters.

26. The T-NET system is designed to cause its principal transmissions to occur only during the 25% non-visible transmission time, and then using only such waveforms and power levels that would not cause interference to the television functions that must be accomplished at those times. Those skilled in television waveform design can

readily understand how T-NET signals that originate at or near the TV transmitter and propagate with it can be coordinated with the TV signal so that they always appear in the horizontal or vertical blanking intervals and consequently are never visible. On the other hand, signals transmitted from remote subscribers cannot be so coordinated, because their transmitted signals propagate in all directions and thus can at best be only in "synchronization" for a brief moment in time and space. Indeed, T-NET signals transmitted from remote locations in the horizontal blanking interval (HBI) could at best be coincident with the HBI for only about eleven microseconds, the approximate duration of the HBI. Since radio waves travel slightly over one mile in these eleven microseconds, one can further visualize how T-NET signals might be kept "synchronized" within a one-mile radius surrounding any particular transmitting subscriber RF modem. Fortunately, this momentary coincidence is sufficient to essentially eliminate TV interference, because the rate of T-NET signal space attenuation with distance is so rapid that by the time it reaches a distance of one mile, it is nearly one billion times weaker (-90 dB) and of negligible interference potential. Consequently T-NET signal pulse waveforms are designed so that when they are of a magnitude that might conceivably cause interference, those magnitudes exist only in the immediate vicinity of the subscriber and within the

HBI and are thus invisible. This might more properly be called "space synchronization." RTT has been able to reliably send signals over distances in excess of 25 miles using these techniques, while employing average power level of only a few milliwatts without any interference whatsoever to signals in the adjacent or other television channels. The test results will be summarized later in these comments.

27. The T-NET system design problem is much greater in scope than simply devising waveforms which prevent television interference. Effectively orchestrating transmissions from several hundred thousand independent RF modems, tens of thousands of which may be simultaneously transmitting, is also a formidable task. While a complete understanding of how the T-NET system accomplishes this result would require a comprehensive discussion beyond the scope of these comments, it is based on the relatively simple concept described below.

28. The outgoing horizontal synchronizing pulses of the host television signal are visualized as analogous to the outgoing pulses of a radar transmitter. These pulses propagate outward and illuminate and reflect from the thousands of TV antennas installed by television viewers. These reflected "echos" only exist for brief moments coincident with the time when the horizontal pulses illuminate the subscriber's antenna. In actuality, these reflected pulses are

enhanced and offset in frequency onto an adjacent television channel by the RF modems and are detected at a central receiver location; they constitute the inbound data transmitted from subscribers. For fixed location subscribers, the reflected pulse arrival time can be accurately predicted in time because of the known distance, and this significantly increases the detection reliability. Furthermore, T-NET employs directional antennas at these central receiving locations to partition the service area into angular sectors. This arrangement has the additional benefit of being able to provide a measurement of the direction to each individual subscriber; and since the system design is inherently like radar, the distance to the subscriber can be accurately measured as well. RTT has consistently measured subscriber distances to an accuracy of about 500 feet. The location of mobile "targets" (e.g. subscribers in vehicles) can also be measured and "tracked," and data links can be established with the targets. Conceptually, one can think of this radar-like operation as "space division multiplexing."

29. By appropriately selecting the pulse width of the reflected echos, and bearing in mind well known relationships between pulse width and bandwidths, one can optimize the T-NET time-frequency-space multiplexing trade-offs for different system applications. It is through such computations that RTT has determined that 300,000 subscribers could

be accommodated in a city such as Los Angeles, each with a signaling rate comparable to existing telephone modems such as those commonly used with personal computers.

30. RTT has thus described the rationale for two of the three T-NET design mechanisms enumerated at the beginning of this section. The third mechanism, the "synergetic modulation," will now be briefly described.

31. The residual RF carrier of a television signal is very powerful. Indeed, it contains more than half the power of the video signal. RTT has found through theoretical studies and by experimentation that it is possible to inject T-NET sideband signals that, to T-NET receivers, have the appearance of sidebands originated by the television transmitter, even though such sidebands may be injected at points remote from that station. This is important because it then becomes possible to simplify the design of T-NET receivers which must detect those sidebands. It makes the overall T-NET signal transmission more reliable, because it can profitably employ the very powerful TV residual carrier for its own detection and demodulation process. While it is true that such "pseudo sidebands" do not bear the strict phase relationships that exist in certain types of sidebands developed by modulating the original carrier, they nevertheless exhibit sufficient similarities to permit significantly improved transmission reliability. A crude analogy is one of

parasites (i.e. T-NET sidebands) which attach themselves to an elephant (the TV carrier) which in turn charges through a dense jungle (the urban radio environment); the parasite thereby travels from point A to B much more reliably. This process of effectively appending sidebands to an existing TV carrier to exploit its carrier energy and/or some of the modulation which it already carries (e.g. horizontal and vertical sync signals) appears to be a unique concept; it has consequently been labeled "synergetic modulation." Synergetic modulation is defined by RTT as: the creation of pseudo radio sidebands on an existing radio signal by means independent of the generator of that signal wherein said means are located at the same or a remote location to thereby enhance the reliability of the pseudo sideband transmissions and minimize mutual interference.

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